

# FOOD SAFETY & QUALITY

WORLD-LEADING INNOVATION IN THE DANISH FOOD CLUSTER

### **INSIDE THIS WHITE PAPER:**

- A farm to fork strategy for dependable food
- Establishing standards for transparent control
- The technology behind food quality and hygiene



Solutions of tomorrow By Denmark



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### Food Safety & Quality

World-leading innovation in the Danish food cluster Version 4.0, 2025

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# EXECUTIVE SUMMARY

The global food supply is facing vast challenges: uneven distribution to consumers, climate change, geopolitical impact, undernutrition and overnutrition. As the population grows, this raises an important question. How will we ensure a reliable supply of safe, high-quality food for all in the future?

This white paper describes how Denmark is contributing to the solutions and to creating new business opportunities for international partners in the process.

Continuous research and development are key to maintaining Denmark's leading position on the international stage

The Danish food cluster stands out for its culture of collaborative innovation. Primary producers work together to produce the very best raw materials for food production. Through their best practices, new international standards for food safety and quality are often set. Danish quality assurance systems are also continuously improved. Today, they secure full traceability and transparency in the food value chain, enabling a fast response to any food safety threat.

Specialised food processing technology and digital tools are another Danish strength. Essential to ensuring the efficiency, productivity and profitability of production, this technology takes food safety, hygiene and quality to new levels.

Continuous research and development are key to maintaining Denmark's leading position on the international stage. With this in mind, a vision for world-class innovation has been set for 2030. The aim is to continue building on the strong foundations for producing safe, high-quality food – to the benefit of the country's international business partners and to consumers around the world.



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### Supporting the SDGs – how does Denmark contribute?

Denmark's agriculture and food sector has an important role to play in ensuring the global population has access to sufficient, safe food. The UN's sustainable development goals (SDG) are a compass for achieving this through best practices in food production, continuous research, consistent development and shared innovation targets.

In Denmark, the commitment to maintaining and improving standards of safety and quality in the food value chain is a strength that supports several SDGs in particular. These include **Goal 2** End hunger, achieve food security and improved nutrition and promote sustainable agriculture; **Goal 3** Ensure healthy lives and promote well-being for all at all ages; and **Goal 12** Ensure sustainable consumption and production patterns.



Achieving the ambitious goals of the 2030 agenda requires global support and partnerships. Extensive collaboration throughout the food value chain and between industry, academia, NGOs and government is all part of the Danish way of working. These united efforts to accelerate national and international initiatives directly contribute to **Goal 17** Strengthen the means of implementation and revitalize the global partnership for sustainable development.



### FOREWORD



### The Danish food sector is committed to securing a safe, high-quality food supply. Cooperation and innovation are essential to solve today's global challenges.

Everyone has a right to food they can trust. In Denmark, producing food to the very best food safety and quality standards has been part of the culture for generations – driven by a tradition for collaborative innovation.

Today, the growing global population, climateinduced disruption and international conflicts are putting even more pressure on food producers to provide a sufficient supply of healthy, safe and accessible food.

Finding solutions to this challenge has long been top priority for Danish authorities, businesses and universities. Through strong public-private partnerships, their joint efforts have raised international standards for food safety and quality, providing a guiding light for food producers in many other nations.

Today, Denmark is a frontrunner for safe food production, and our track record is long. We were the first country to introduce compulsory pasteurisation of milk, the first to ban trans fats, one of the first to ban growth promoters and one of the few countries granted special EU status as a producer of salmonella-free table eggs and chicken meat.

For many global producers, the Danish food sector is a source of inspiration. Our food manufacturers use increasingly smarter systems to ensure the safety, quality and sustainability of their food products and to avoid food loss and waste. Our ingredient and technology companies help food producers meet consumer expectations for uniform safety and quality. Other technology enterprises develop analytical tools for monitoring process stability, microorganisms and chemical substances in primary food production.

At government level, maintaining this leading position and developing new technologies and solutions are key areas of focus and investment. The goal, as always, is to keep the Danish food cluster one step ahead of the global agenda by facilitating collaborative partnerships for the innovation of timely solutions. I am proud that Danish contributions to food safety and quality are in daily use, both at home and abroad. Here in Denmark, a continuous flow of new technology is available to increase production output and consolidate our position as a food safety leader. Abroad, our technology helps farmers and food processors take their food safety standards to new heights.

Denmark has bilateral cooperation agreements with many countries and is a proactive participant in the work of international standard-setting bodies, including the World Organization for Animal Health and Codex Alimentarius.

This white paper covers our wide portfolio of food safety and quality competences. I am very pleased to share it with you and hope you will be inspired.

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Jacob Jensen Minister for Food, Agriculture and Fisheries

### CHAPTER 1 PARTNERING IN THE FACE OF GLOBAL CHALLENGES THE COLLABORATIVE RESPONSIBILITY FOR SAFE, HIGH-QUALITY FOOD

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### Global population growth, climate change and food security have placed the need for safe, high-quality food firmly in the spotlight. Danish collaboration is driving up standards.

The ultimate goal is to provide consumers with healthy meals where safety, quality and profitability coexist with sustainable production The need to ensure universal access to safe and sustainable food is more important than ever. Throughout the food value chain, forward-looking collaboration is key to finding the solutions.

The numbers speak for themselves. According to the UN Food and Agriculture Organization (FAO), global food production needs to increase by around 70 percent in the first half of the century to feed a global population of around 9.1 billion in 2050. The food produced must be safe, sustainable, accessible and high quality.

Climate change, global conflicts, emerging diseases and shifting consumer trends add to the complexity and require new ways of thinking and acting.

Solutions to such challenges rely on farm to fork innovation – new ideas, new raw materials, new technology, new ways to interact and collaborate, and new ways to make use of data. The ultimate goal is to provide consumers with healthy meals where safety, quality and profitability coexist with sustainable production.

### A collaborative foundation

The Danish agriculture and food sector is rooted in high standards of food safety and quality assurance, enabled by a culture for collaboration that spans industry, academia, organisations and government authorities. In a fully integrated value chain, every stage of production is in focus, giving customers and consumers full confidence in the products they buy.

The collaborative tradition dates back to the late 19th century, when Danish farmers established the first dairy and slaughterhouse cooperatives. These cooperatives laid the foundation for Denmark's development into a leading exporter of safe, high-quality food products. Today, those early cooperatives have evolved into multinational companies.

The Danish food industry embraces collaboration as a means to innovation, whether through shared research, cooperative in-



In a fully integrated value chain, every stage of production is in focus, giving customers and consumers full confidence in the products they buy

vestments or collective efforts to improve global standards. National funds that support food safety and quality research across the food value chain are an important element in this.

#### **Commitment beyond requirements**

A strong commitment to risk management means Danish companies often exceed legal requirements, setting food safety standards that go beyond those of many other countries. For example, Denmark's Salmonella Action Plans, in operation since 1995, cover every stage of the production process for pork, beef, poultry and eggs. Extensive training, detailed risk assessments and management systems such as Hazard Analysis and Critical Control Points (HACCP) support this risk-based approach, along with a well-established self-monitoring system – the outcome of close collaboration between food producers and government authorities. Comprehensive data capture and analysis maintains traceability and enables data-driven decision-making.

Self-regulation, voluntary agreements and stringent compliance with national and international food regulations have fostered a high level of trust in Danish food products – at home and abroad.

The strong relationships between Danish producers, researchers and authorities have created an environment where openness and a shared sense of responsibility guide everything from farm to fork. **Food safety** is a welldocumented discipline, process or action that keeps food free of substances that are potentially harmful to consumer health.

**High food quality** is defined as food products and solutions that have all the desirable characteristics which make them attractive to consumers.

**Food security** is about the ability of an individual to access sufficient and nutritious food. Food safety is essential to achieving food security.

Source: UN Food and Agricultural Organization





### CHAPTER 2 THE RAW MATERIALS OF CONSUMER TRUST INVESTMENTS IN ASSURING FOOD SAFETY AT SOURCE

### Farmers and food manufacturers have a mutual interest in high-quality raw materials. Their cooperation helps inspire international confidence in Danish food products.

Global reports of food contamination remain alarmingly high. According to the UN Food and Agricultural Organization, one in ten people in the world fall ill after eating contaminated food, and 420,000 die each year. Keeping food fit and safe for human consumption is a major challenge – with high costs for everyone involved.

#### Legislation in dialogue

In Denmark, the national food regulations closely follow the food safety legislation set out by the EU and may exceed it. All legislation is prepared and implemented in dialogue with the authorities. food sector. and research and innovation institutions. Through this collaboration, it is possible to set ambitious food safety and quality goals. The Danish tradition for investing in food safety starts with the raw materials produced on farms, landed by fishing boats or imported into the country for processing. This investment has helped build a high level of confidence in Danish food products worldwide. To maintain that trust, a coherent control structure is in place, covering the entire food value chain.

#### Safeguarding livestock health

Denmark's contingency plans for disease control serve as an excellent illustration of the national food safety commitment.

Like all countries, exports of live animals and meat depend on the ability to breed healthy animals and avoid outbreaks of contagious livestock diseases.

Denmark's safeguard against diseases is the veterinary contingency – a long-standing and close-knit cooperation between the authorities and industry on surveillance, control and prevention.

By documenting livestock health at all times, disease risks can be quickly isolated and eliminated.

#### Incentive models drive quality

For all types of raw material, there are certain traits that directly influence production efficiency and the quality of the final food product. This could be the content of fat and protein in raw milk, the fat and lean meat ratio, or the moisture and protein content of grain-based cereals – to name a few examples.

Denmark's long tradition for cooperation between farmers and food processors supports a common interest in high-quality raw material production. One important motivator is a transparent payment system, where food processors pay for the quality that farmers provide. In this way, farmers have a clear incentive to deliver the minimum quality defined by the payment system and are rewarded with premium payments when they optimise their production practices to supply raw materials of the highest quality. Denmark's long tradition for cooperation between farmers and food processors supports a common interest in high-quality raw material production

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# CLEAN DAIRY FEED GIVES 10% MORE MILK

TH Group was able to register a 10% increase in milk yield overall and an excellent return on investment Vietnam's leading milk producer turned to Danish technology provider SKIOLD for a reliable solution that would optimise the performance of its 20,000 dairy cows while lowering average production costs.

The Vietnamese company TH Group had an ambition to deliver fresh milk to Vietnamese consumers. To realise that goal, the company needed to reduce the natural mycotoxins in the feed that were compromising animal health and yield. SKIOLD supplies some of the world's most innovative machines for cleaning and sorting cereals and seeds. Capable of handling up to 300 tonnes of cereals an hour, the machines effectively remove mycotoxins, helping to ensure the uniform high quality of the finished feed and reducing the need to add toxin binders.

### Automatic controls

The SKIOLD team included a universal cleaning machine in the design for a complete feed mill for TH Group, along with grinding, dosing and mixing processes – all equipped with automatic controls.

Soon after the feed mill went into operation, the improvement was clear. Feed costs went down and the cows began to produce more milk. Before long, TH Group was able to register a 10% increase in milk yield overall and an excellent return on investment.

For SKIOLD, the feed mill was one in a long line delivered to milling plants and livestock producers in many parts of the world. With 140 years of experience to draw on, the technology company is a well-established partner for bespoke solutions.





### THE DANISH TRANSPORT STANDARD KEEPS LIVESTOCK FREE FROM DISEASE

Biosecurity is paramount when transporting livestock across borders. Should disease break out, the economic consequences would be dire for any livestock-exporting nation.

In Denmark, the Danish Veterinary & Food Administration, agricultural industry and scientific institutions collaborate closely to protect the millions of live pigs that are exported each year. Their role is to adopt measures, develop recommendations for farmers and adjust contingency and action plans to prevent the spread of African swine fever and foot-and-mouth disease, for example.

One preventive measure is the DANISH Transport Standard (DTS), which covers livestock hauliers, collection centres, exporters and the cleaning and disinfection stations for all transport vehicles that enter Denmark from abroad.

Approved DTS hauliers are required to use DTS cleaning and disinfection stations before loading and transporting herds that have been certified according to the DANISH Product Standard.

### Central register for livestock transport

According to Danish law, all pig and cattle transports must be registered in the Central Husbandry Register. This transport data is then merged with a central database, which



collates washing and disinfection certificates, to verify DTS compliance.

If vehicles have entered countries identified as high risk or are unable to document their route over the previous seven days, strict

According to Danish law, all pig and cattle transports must be registered with the Central Husbandry Register quarantines are imposed before they are allowed to approach a herd.

As wild boar poses a risk of African swine fever infections, a fence along the Danish border ensures no wild boar can enter the country – another important step in risk minimisation.

#### **Case by Danish Agriculture & Food Council**



### PESTICIDE TRACES ARE LOWEST IN DANISH FRUIT AND VEGETABLES



Compared to other countries both inside and outside the EU, the level of pesticide residues is notably lower

A long-standing commitment to pesticide reduction has a measurable impact on fruit and vegetables from Danish farms. Compared to other countries both inside and outside the EU, the level of pesticide residues is notably lower. According to an annual report about pesticides in foods by the Danish Veterinary and Food Administration and the Technical University of Denmark, a recent random check found pesticide residues on 19% of Danish vegetables, compared to 58% of vegetables from the rest of the EU.

A random check of fruit produced similar results. Here, pesticide residues were found on 68% of Danish fruit. The figures for fruit from other EU countries and countries outside the EU were 82% and 81% respectively. The annual report continuously shows that no Danish product exceeded the legal maximum for pesticides. Of the fruit and vegetables allowed into Denmark from other EU countries, less than one percent exceeded the maximum, while four percent of produce from non-EU countries were above the limit.

> Case by Danish Veterinary and Food Administration The Technical University of Denmark

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### CHAPTER 3 **ESTABLISHING STANDARDS FOR TRANSPARENT CONTROL** TRUSTED FOOD EXPORTS START WITH BEST PRACTICES AT HOME

# The high level of animal health and food safety in Denmark has opened the door to many export markets. Food producers' own-check programmes are a primary reason for this achievement.

Several decades have passed since the last outbreak of foot-and-mouth disease in Denmark – a record that reflects the high standard of animal health and food safety control. Today, Danish food exports are accepted in more than 200 countries around the world. During Denmark's early years as a food exporting nation, the Danish Veterinary and Food Administration (DVFA) had full responsibility for the quality and safety of food products. But, as the Danish food cluster has grown, food producers have taken an even more proactive role in maintaining and exceeding these high food safety and quality standards.

The own-check system means companies are required to implement transparent control systems that document the food safety and hygiene of their food production and their compliance with control procedures and legislation. Regular checks by DVFA ensure these requirements are met.

#### The value of own-checks

The introduction of the own-check programme coincided with the first EU directive on food hygiene in 1994. This required food businesses to identify food safety risks in their activities and implement and maintain adequate food safety procedures based on the principles of the Hazard Analysis and Critical Control Points (HACCP) system. In the years that followed, all companies prepared an approved own-check programme, often using existing industry guidelines as a starting point.

Own-check is today a well-established system for verifying food safety and quality in production and providing the necessary insights for intervention if required. In addition, the Danish food industry has developed internationally recognised standards, including the Global Red Meat Standard (GRMS) and DANISH Transport Standard. These standards support food producers in complying with international legislation and industry best practices.

### Compliance with global standards

Over the years, food manufacturers have acted on a growing customer demand for third-party certification of their compliance with recognised global standards, which often differ from legislative requirements. In Denmark, manufacturers develop their own efficient own-check programmes to prepare for third-party certification. In some cases, these certifications replace part of the official control by DVFA. High-scoring areas in the third-party audit, such as pest control, are then not subject to further control, freeing the DVFA to focus on other aspects of food safety and quality. Today, Danish food exports are accepted in more than 200 countries around the world







## THE GLOBAL RED MEAT STANDARD - DELIVERING TRANSPARENCY TO THE MEAT INDUSTRY



### The GRMS ensures transparency in animal welfare, quality, food safety and hygiene through:

Comprehensive requirements	Covering 19 key areas, including HACCP, traceability, product handling, hygiene and animal welfare.
Independent certification	Third-party audits ensure compliance with ISO/IEC 17065, verifying standards in facilities.
Animal welfare focus	Specific criteria ensure humane treatment, enhancing meat and safety.

These measures provide a structured, transparent framework for maintaining high standards in meat production.

The Danish meat industry is renowned for its ability to produce safe, high-quality meat for customers around the world. Today, this experience and expertise benefits meat manufacturers everywhere through the Global Red Meat Standard (GRMS).

Developed by the Danish Agriculture & Food Council in partnership with its slaughterhouse members and the Danish Meat Research Institute, GRMS was published in 2006. It was recognised by the Global Food Safety Initiative just three years later. Like other global standards, GRMS qualifies for third-party certification.

The aim of GRMS is to deliver transparency within animal welfare, quality, food safety and hygiene in factories that slaughter, cut, debone, process and handle meat and meat products from pigs, cattle, lambs, sheep, goats and horses.

GRMS is maintained and continuously developed in cooperation with meat industry and food safety experts and industry association professionals. The current version of the standard is available at www.grms.org

### **Case by Danish Agriculture & Food Council**



# DAIRY FARM PROGRAMME DELIVERS HIGH QUALITY MILK

Strict control procedures are an absolute necessity to ensure the consistent quality of milk – especially when it is produced by farmers in seven countries.

At the Arla dairy cooperative, the Arlagården programme has contributed to improved farming standards in Northern Europe since 2004.

Arlagården is an example of how a focus on quality, traceability and sustainability can make a big difference in primary production by helping farmers ensure the high quality of their produce

Since its initial introduction in Denmark and Sweden, the farm management programme has been implemented in Germany, the Netherlands, Luxembourg, Belgium and the UK. The objective is to secure excellence in milk production by setting out requirements for milk quality and food safety, animal welfare, climate and nature, and people.

Twice a year, the farmers are required to evaluate and document their on-farm practices against Arlagården. In this way, Arla can follow the farms' performance and support their continuous improvement.



Each farm is subject to a third-party audit at least once every three years. In between, specialist farming consultants pay regular visits to give advice and ideas and ensure procedures are carried out.

Arlagården is an example of how a focus on quality, traceability and sustainability can make a big difference in primary production by helping farmers ensure the high quality of their produce.

**Case by Arla Foods** 

### CHAPTER 4 A FARM TO FORK STRATEGY FOR DEPENDABLE FOOD CROSS-DISCIPLINARY COLLABORATION ENSURES FOOD

CROSS-DISCIPLINARY COLLABORATION ENSURES FOOD SAFETY AND SECURITY



### In 1898, Denmark became the first country to introduce compulsory pasteurisation of milk. It was the start of a long tradition for identifying and eliminating food-borne risks to consumer health and ensuring the consistent quality of food production.

Even the most careful selection of raw materials cannot eliminate all potential microbiological and chemical hazards in the final food products. A farm to fork strategy is critical to assuring the quality and safety of foods throughout production, during transport and storage and all the way to consumers.

Knowledge of food contaminants, production processes and food stability during shelf life continues to grow. As new health risks become apparent, the need for evaluation and action plans is ongoing.

Danish food products cross international borders, and experience shows that collaboration between governments, producers and consumers is critical to making the food supply system work. A high level of trust when sharing knowledge between partners plays an important role in effective food quality and safety assurance.

#### Voluntary action on Salmonella

Denmark has a strong track record in identifying food safety risks and implementing effective control strategies. In the late 1980s, rising Salmonella infections from chickens and eggs led to swift collaboration between authorities and the poultry industry. The University of Copenhagen, the Ministry of Food and the Danish Poultry Council developed a national action plan, resulting in industry agreements on feed, imports and biosecurity. In 1996, the voluntary plan was replaced by an official control programme, drastically reducing infections. By 2015, cases from chickens and eggs had been eliminated, earning Denmark a special Salmonella-free status in the EU. The action plan remains in place to sustain this success.

#### Pioneers against antibiotic resistance

Denmark also ranks among the countries with the lowest levels of antibiotic resistance in humans and animals. Continuous research plays a crucial role in maintaining this



With strong political support, targeted public funding and wide stakeholder engagement, Denmark has all the right conditions for shaping a sustainable future

high level of food safety. DTU National Food Institute is at the forefront of this effort, having pioneered surveillance programmes that monitor antibiotic use and resistance. As a result, the institute is today a designated EU reference laboratory and a WHO and FAO collaborating centre for antibiotic resistance.

In 2000, Denmark became the first country in the world to ban antibiotic growth promoters in animal feed, a policy that was adopted across the EU in 2006. Driven by ongoing collaboration and innovation, Denmark's proactive approach has set an international benchmark.

#### First in the EU with trans-fat ban

Occasionally, food safety risks stem from processing methods. Such is the case with trans fats, which are formed during partial hydrogenation – a method that has been widely used in margarine production, for example. Scientists have linked trans fats to cardiovascular disease due to their impact on cholesterol.

When the Danish Nutrition Council reported on the health risks of trans fats in 1994, the margarine industry was quick to act. That same year, trans-free margarines were launched on the market. In 2004, Denmark led the way by becoming the first EU member state to ban trans fats in foods produced and sold in the country.

#### Strict regulations on nitrite use

Denmark has strict limits on the use of nitrite compared to the rest of the EU. Since 1995, special regulations have been in place for the use of nitrite (E249 and E250) in meat products to safeguard public health.



Meat products imported into Denmark must also adhere to these national standards. Despite these lower limits, Denmark has successfully prevented outbreaks of botulism, which nitrite is known to inhibit.

### Safeguards for new protein sources

Novel proteins are subject to the same strict food safety procedures as all other foods in Denmark, including HACCP-based self-monitoring by producers and inspections by the Danish Veterinary and Food Administration. These safeguards ensure new proteins live up to established standards for food safety and hygiene.

In 2023 the Danish government launched the Strategy for Green Proteins for Animals and Humans, which creates a framework for the agro-food industry to invest in sustainable, high-quality protein sources. The goal is to boost domestic production of plantbased proteins significantly by 2030, reducing dependence on imports and supporting a greener food system. Promising sources include legumes, grasses, seaweed, algae, insects, precision fermentation and biorefining.

### **Plant-based collaborations**

Analyses show that global demand for plantbased products will continue to accelerate. However, the shift towards plant-based diets requires the development of novel processing technologies and the adaptation of food safety practices to new microbiological risks.

To support this transition, the Danish Ministry of Food, Agriculture and Fisheries launched the Danish Action Plan for Plant-Based Foods in 2023. The plan addresses the entire value chain – from farm to fork – with the goal of improving food safety, supporting sustainable production, updating safety standards and fostering innovation and international trade. Developing new plant-based products is both time and investment-intensive. Strategic, cross-sector collaboration is crucial to ensure scalable solutions and global competitiveness. With strong political support, targeted public funding and wide stakeholder engagement, Denmark has all the right conditions for shaping a sustainable future.

A farm to fork strategy is critical to assuring the quality and safety of foods throughout production, during transport and storage and all the way to consumers

### **FOOD SAFETY IN DENMARK – THE HISTORICAL HIGHLIGHTS**

1898	Denmark becomes the first country to introduce compulsory pasteurisation of milk.				
1980s	The University of Copenhagen, the Ministry of Food, and the Danish Poultry Council <b>develop a voluntary national</b> <b>action plan to eradicate Salmonella.</b>				
1995	<b>Denmark implements special regulations for the use of nitrite (E249 and E250)</b> in meat products to safe-guard public health.				
1996	The voluntary national action plan to eradicate Salmo- nella is replaced by an <b>official control programme.</b>				
2000	Denmark becomes the first country in the world to <b>ban antibiotic growth promoters in animal feed,</b> a policy adopted across the EU in 2006.				
2004	Denmark becomes the first EU member state to <b>ban trans fats</b> in foods produced and sold in the country.				
2015	Denmark gains <b>special Salmonella-free status</b> in the EU. The action plan remains in place.				
2023	Launch of the <b>Danish Action Plan for Plant-Based Foods</b> and the <b>Danish Strategy for Green Proteins for Animals</b> <b>and Humans.</b>				



### **EFFECTIVE TRACEABILITY SYSTEM RULES OUT RISK WITHIN 24 HOURS**

Millions of eggs were recalled when it came to light that eggs distributed to markets all over Europe could be contaminated with fipronil, an insecticide toxic to humans.

Denmark's effective food traceability system was quick to respond.

As the news broke, the Danish Veterinary and Food Authority (DVFA) recognised that the threat to consumers could only come from imported eggs, because no Danish producer used fipronil.

The authority immediately contacted all major food outlets to find out if any fresh egg imports may have come from the poultry farms suspected of using the insecticide.

Ensuring a high level of consumer trust and food safety is a shared goal for Denmark's food authority and industry

### No shipment is too small

Due to the speed and efficiency of its communications, the DVFA was able to track down a small shipment of 40 eggs to a remote Danish bakery – the same day the eggs were delivered. This made it possible – still the same day – to send the local food inspector to the bakery to ensure no eggs were used.



Ensuring a high level of consumer trust and food safety is a shared goal for Denmark's food authority and industry. Transparency not only benefits consumers. It also strengthens the international status of food from Denmark.

The European Commission highlighted this reputation when it rewarded the Danish poultry industry with special salmonella-free status in the EU.

Case by The Danish Veterinary and Food Administration

# WORLD'S FASTEST SALMONELLA TEST IMPROVES FOOD SAFETY



Using the Salmonella Velox qPCR test kit, it is possible to obtain results in less than six hours - compared to around three to four days with conventional tests Salmonella is a major cause of food-borne disease around the world. In addition to the human suffering caused, the economic impact can be measured in health costs, expensive product recalls and food waste.

Food producers everywhere recognise the importance of protecting consumers and their business from Salmonella risks. However, until recently, their efforts were limited by the slow speed and inaccuracy of the available tests. To overcome this major food safety hurdle, Danish company DNA Diagnostic has developed a fast and reliable kit for Salmonella detection.

### From three-four days to six hours

Using the Salmonella Velox qPCR test kit, it is possible to test, for example, meat, seafood and environmental samples and obtain results in less than six hours – compared to around three to four days with conventional tests. The Salmonella Velox method is certificate by NordVal international (NordVal Certificate 046) as an alternative method to the ISO method for Salmonella detection, ISO 6579.

If Salmonella is detected, the speed of the result means food producers can identify and resolve the root cause and, if necessary, initiate a recall before an infected batch reaches consumers.

Faster testing frees up cold-store capacity, enhancing production efficiency overall. In this way, the innovative test kit not only ensures food safety, it also cuts costs, waste and energy consumption.

Case by DNA Diagnostic A/S

## RELIABLE DOCUMENTATION OF MEAT AND MEAT PRODUCT SAFETY

All meat producers must document the shelf life and food safety of their products. But satisfying the wide-ranging demands for documentation from customers, third party auditors and authorities is quite a challenging task.

This is why the predictive models of Danish Meat Research Institute (DMRI) have around 2,000 registered users from around the globe.

Called DMRI Predict, the predictive model platform has been developed in collaboration with the Danish meat industry to provide user-friendly tools for assessing food safety and microbiological or sensorial spoilage.

New models are regularly developed and added to the platform, which plays an important role in ensuring the safe production and reliable shelf-life determination of meat and meat products.

### Extensive data from systematic tests

DMRI Predict has set a high standard for versatility, reliability and robustness. The entire model collection is based on data from a large number of systematic shelf life and challenge tests.



Authorities throughout the world accept the use of predictive models as an integral part of the HACCP Program in food manufacturing facilities. American Food Safety and Inspection Services, for example, specifically mention DMRI models in their guidelines.

DMRI Predict is open for all, free of charge and can be accessed at DMRIpredict.dk

**Case by DMRI, Danish Technological Institute** 

DMRI Predict plays an important role in ensuring the safe production and reliable shelf-life determination of meat and meat products

### CHAPTER 5 THE TECHNOLOGY BEHIND FOOD QUALITY AND HYGIENE EFFICIENT PROCESSING SOLUTIONS ENABLE PRECISION AND TRACEABILITY

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### Necessity is the mother of invention in the Danish food industry, where the need for costefficient food production has led to world-leading food technology companies with a strong focus on quality and hygiene.

Danish manufacturers of processing technology and equipment stand out for their strong presence on the global market. Their specialised processing machinery, robots, sensors, analysis tools, and IT and artificial intelligence (AI) systems are essential to the efficient and standardised production of food. Following a tradition for innovation, they continue to meet demands for everbetter food safety, quality and production efficiency.

### Smart tools for quality assurance

Today's technology has moved far beyond traditional quality control based on subjective human assessments of random samples. Intelligent AI-based solutions can now make precise, objective evaluations of all products, ensuring consistent and reliable quality. This extensive data collection further enables predictive analytics, so potential issues can be anticipated and addressed before they arise.

In the Danish pork industry, for example, quality management has been a key focus of the sector's continuous technological development, as illustrated by the Technology Lighthouses of the Decades. Much of this progress has been achieved in collaboration with the Danish Technological Institute.

#### Critical analyses in the dairy

One critical success factor for the production of safe foods is to avoid contaminants that enter the production plant with the raw materials. In the dairy industry, for instance, milk is easily contaminated by harmful bacteria or excessive bacteria growth. Just one bad delivery can spoil a whole product batch. Critical control points through the value chain are key success criteria for managing and avoiding contamination.

Bacterial analysers are a Danish invention, designed for fast, reliable and cheap testing of the bacteria levels in raw milk. When every truckload delivered to the dairy is checked, abnormal bacteria levels can be detected in time.

Danish companies also pioneered membrane filtration technology in dairy processing. Today producers around the world rely on this technology for uniform, high-quality and cost-effective cheese production. Precise analyses of all other dairy ingredients generate instant feedback for efficient process monitoring and control.

### Advances in digital innovation

Advanced automation technology is increasingly widespread, reducing human error, improving working conditions and strengthening food safety. Automated transport systems boost manufacturing capacity, while industrial robots ensure stable, high-quality production. Sophisticated digital solutions are making food safety and quality practices even more precise and efficient. On food processing lines, for instance, Danish companies support the development and implementation of AI, robots, sensors and data management systems to monitor quality and alert operators to deviations and risks. This includes ensuring the efficiency of robust cleaning in place systems, which are essential to maintaining high standards of hygiene.

Advanced automation technology is increasingly widespread, reducing human error, improving working conditions and strengthening food safety



### TECHNOLOGY LIGHTHOUSES OF THE DECADES



### HIGH-TECH ANALYTICAL SOLUTIONS FOR SAFE AND SUSTAINABLE DAIRY PRODUCTION



Using FOSS technology, milk testing centres can program their instruments to screen raw milk samples for known sources of adulterant while determining the milk's composition of protein, fat, lactose and total solids. Results are delivered in less than a minute Milk holds second place on the global list of most commonly adulterated foods. The highest risk is in countries with an emerging dairy sector, where control systems may be less well established. But even the most experienced milk hauliers and processors must stay alert to contaminants from tanks, equipment and criminal activity.

Innovative solutions from Danish analytical technology supplier FOSS empower the global food industry to safeguard food safety and quality, optimise raw material use and boost productivity.

In the dairy industry, the company's hightech testing solutions are a standard quality assurance tool. By screening for bacteria, contaminants and overall milk quality, dairies can both ensure high standards of food safety and fair payment for farmers.

### **Flexible programming**

Using FOSS technology, milk testing centres can program their instruments to screen raw milk samples for known sources of adulterant while determining the milk's composition of protein, fat, lactose and total solids. Results are delivered in less than a minute.

FOSS has pioneered the use of Fourier Transform Infrared analysis to meet this specific need. By comparing samples with the composition of normal milk, the technology quickly identifies individual adulterants that pose a threat to consumer health.

For decades, FOSS has worked with the dairy sector to optimise livestock yield and productivity and ensure efficiency and transparency across the value chain – driving smarter, more sustainable food production.

# AI DELIVERS SAFER, SUPERIOR MEAT

Ensuring consistent food safety and quality is critical in the global meat industry. Traditional quality control methods rely on manual inspection, which is time-consuming and prone to human error.

The largest meat processing company in Europe, Danish Crown has adopted a more precise and efficient solution. By integrating Al-driven image recognition and machine learning in production lines, Danish Crown has automated quality control to ensure safer, higher-quality meat products.

#### Precision, safety and waste reduction

Cameras and sensors capture real-time images of each meat product, which AI analyses for deviations in colour, texture and fat distribution. Through continuous, objective assessments and real-time adjustments, food waste is reduced and efficiency improved.

Advanced equipment also inspects the surfaces of raw materials for foreign objects, such as metal, plastic and paper, before they enter production. Early detection and elimination minimise the risk of contaminants in the final products, while automatic storage of raw material images simplifies traceability and follow-up processes.



### The key to consumer trust

By ensuring consistent food safety and quality standards, AI optimises production, prevents waste and strengthens consumer trust in all Danish Crown's meat products.

**Case by Danish Crown** 

By ensuring consistent food safety and quality standards, AI optimises production, prevents waste and strengthens consumer trust in all Danish Crown's meat products



# CLEAN NOZZLES OPTIMISE SPRAY DRYER SAFETY AND PERFORMANCE



A typical plant with round-theclock production and a capacity of five to seven tonnes an hour can expect an annual yield improvement of around 40 to 60 tonnes Combustible dust is a fire and explosion hazard when food manufacturers spray-dry milk and other food products into a powder format. The primary source of the risk is the residues that form in the pressure nozzles when liquid dairy or food concentrates are atomised into small droplets before drying.

Danish technology supplier GEA Process Engineering has patented a nozzle purging system to eliminate the hazard and, at the same time, prevent unwanted microbiological growth and loss of yield. The nozzles are routinely taken out for cleaning and replaced during operation, and it is this procedure that can lead to the formation of unwanted food residues. Using the GEA Clean Purge system, such residues can be expelled from the nozzle prior to the replacement operation.

In this way, there are no deposits left that could compromise hygiene or initiate a selfcombustion process.

### Significant operational savings

In addition to improving safety in the production plant, the cleaning system provides significant operational savings by reducing cleaning frequency and improving equipment efficiency overall. Water, energy and chemical consumption are significantly lower with the system installed.

The yield improvement is also considerable. By ensuring all the food concentrate in the system is utilised before cleaning cycles, a typical plant with round-the-clock production and a capacity of five to seven tonnes an hour can expect an annual yield improvement of around 40 to 60 tonnes.

### **Case by GEA Process Engineering**

### IN-HOUSE MICROBIAL ANALYSIS GIVES THE FULL PICTURE - FASTER

Food manufacturers often have to wait at least a week when they send product and process samples to an external laboratory for microbial analysis. The results that come back are critical to ensuring the quality and safety of their products – and the reputation of their brands.

For Danish microbiology specialist ISI Food Protection, it has long been clear that manufacturers not only need faster analysis results. They also lack a complete picture of the microbial risk.

The purpose is to help manufacturers establish their own facility for in-house metagenomic analysis – reducing the waiting time for results from days to less than 12 hours

The reason for this shortfall is the continued reliance on traditional cultivation methods. Widely used to detect potential pathogens and spoilage bacteria in food products and the production environment, these methods are not equipped to reveal all microorganisms present.

This is why, for some years, ISI Food Protection has offered metagenomic analyses, which ensure comprehensive identification of bacteria, yeasts and moulds via their DNA.

### **Results in hours**

Now the microbial experts are taking the next step with the launch of a new platform called OMNI Track Pro<sup>™</sup>. The purpose is to help manufacturers establish their own facility for in-house metagenomic analysis – reducing the waiting time for results from days to less than 12 hours. ISI Food Protection advises on lab setup and workflow, provides training in best practices and delivers user-friendly software for microbial classification, with subsequent advice on data interpretation.

Faster, more precise results enable food producers to act fast on risks, make better and safer products and minimise downtime in production. That benefits food brands and the consumers who buy them.

### **Case by ISI Food Protection**



### CHAPTER 6 RESEARCH AND INNOVATION TOWARDS BETTER AND SAFER FOOD SOLVING GLOBAL CHALLENGES THROUGH THE DANISH EXPERT NETWORK







International customers often experience that their Danish partners have an ambitious approach to development projects, where the goal is not to meet expectations but to exceed them

### Denmark is working towards a future where safe, healthy and sustainably produced food is accessible to all.

Continuing innovation is essential to secure a reliable and accessible food supply for the world's growing population. So, it is only natural that food safety, health and nutrition, and sustainable production will become even more important in the years ahead. This is where Denmark's triple helix model of innovation – involving industry, academia and government institutions – plays a key role.

A food research and innovation strategy sets out Denmark's vision up to 2030 and beyond. Drawn up by the agricultural sectors in cooperation with several private companies, the strategy highlights key challenges for future research and innovation activities.

The objective is to convert these challenges into opportunities that will both benefit global society and keep the Danish food cluster at the forefront when producing foods, ingredients, process equipment and services and developing the industry overall. Politicians, funding bodies, industry and the research community are all part of the collaborative network that is putting action behind the strategy.

International customers often experience that their Danish partners have an ambitious approach to development projects, where the goal is not to meet expectations but to exceed them.

### Cross-sector collaboration drive innovation

One approach to fostering rapid knowledge transfer and stronger research collaborations is the mission-driven partnerships supported by Innovation Fund Denmark. The partnerships' joint ambition is to transform the way research and innovation are conducted in Denmark.

AgriFoodTure is a research and innovation partnership for leading researchers, businesses and organisations, who are working to develop new technology and tools for sustainable agriculture and food.

Another Danish initiative is The Green Development and Demonstration Programme (GUDP), which is a government funding scheme under the Danish Ministry of Food, Agriculture and Fisheries. GUDP supports innovative projects across the value chain and aims to promote a green and economically sustainable development in Denmark's food sector. The green goals focus on a high level of climate, nature and environmental protection, along with animal welfare, food safety and health.

In 2023, The Plant Fund was established to promote the production and consumption of plant-based foods in Denmark as part of the green transition. The fund supports projects that increase demand, improve production and strengthen collaboration within the sector.

### World-class innovation towards 2030

### Denmark's food research and innovation strategy focuses on the five key challenges facing the food industry:

- 1. Resource utilisation and sustainability
- 2. Climate and the environment
- 3. Healthy, safe and high-quality raw materials
- 4. Animal welfare and health
- 5. Biodiversity and nature



#### The big potential in data

One of Denmark's hidden strengths in the digital era is in the production and collection of huge amounts of data throughout the value chain – from raw material producer to the final consumer. This is based on a long tradition for collecting data for traceability purposes in primary production and a high level of automation that enables the collection of large data sets. Al ensures the efficient use of big data by identifying patterns, extracting insights and automating complex processes.

Compared to most other countries, these data-compiling capabilities are unrivalled. As a result, Danish producers of agricultural and food technology are at the forefront of complex data analysis. The ability to exploit the value of big data and AI is particularly important to tomorrow's innovation, including the new solutions that will improve food safety and quality even further.

#### **Ongoing research in risk control**

Globalisation is another factor in the drive towards ever-better food safety. With the increased transportation of people, animals and consumer goods around the world comes a higher risk of spreading communicable disease. Epidemics can have a serious impact on food production and, in the affected areas, will shut down exports. In Denmark, research and innovation focuses on establishing advanced tools and reliable track and trace systems to ensure consistent high standards of food safety and quality, guarantee the origin of locally and internationally sourced raw materials, and minimise the risk of food fraud

While Danish food production is known for well-documented food safety, high quality standards and strong reliability, this should never be taken for granted. There will always be food safety challenges to overcome, such as antibiotic-resistant bacteria or toxic chemical compounds. For this reason, food safety solutions to control these threats are high on Denmark's research and innovation agenda.

### **Rapid analysis and prediction**

Analytical tools play a significant role in achieving that control and securing a competitive advantage. This includes quantitative measurements of food components and contaminants and rapid methods of analysis that can reduce testing time and, hence, the time to market for new products.

The development of such tools requires a fundamental knowledge of the food safety risks that arise when changing product formulations – for example, when adding new ingredients, reducing salt or sugar, or changing the pH or heat treatment. The food industry must also be able to predict the changes that take place in products during transportation and shelf life and to understand how processing and packaging affect food quality.

In Denmark, research and innovation focuses on establishing advanced tools and reliable track and trace systems to ensure consistent high standards of food safety and quality, guarantee the origin of locally and internationally sourced raw materials, and minimise the risk of food fraud. These capabilities are a cornerstone of Denmark's reputation as a leading food nation.

# **COLLABORATION INSPIRES NEW USES OF FERMENTATION**

Millions of tonnes of meat, dairy and readyto-eat food products are thrown away every year due to their high vulnerability to food pathogens and spoilage bacteria.

Sometimes the best way to outsmart such contaminants is to recruit beneficial bacteria – through fermentation with a protective effect.

Using this strategy, Danish company Novonesis has developed a range of protective biosolutions that help keep meat, dairy and other food products safe and fresh for longer while maintaining taste and texture.

### Inspiration from collaborative research

More than two decades have passed since research at the University of Copenhagen provided inspiration for the range. A collaborative study by the Danish Technological Institute and the meat industry found that the lactic acid bacteria naturally present in meat products can provide protection against the effect of unwanted flora.

Drawing on these findings, Novonesis went on to find those strains of lactic acid bacteria that can effectively protect meat products from contamination with Listeria monocytogenes. This marked the beginning of what is now an extensive portfolio of lactic acid bacteria and other food cultures that both inhibit food spoilage and protect against harmful contaminants.



### **Biosolutions with multiple benefits**

When used in bacon or salami, the cultures provide a series of added benefits – naturally improving colour, flavour and texture development without need of chemical additives.

Novonesis has also helped save over one million tonnes of yoghurt by using specific beneficial bacteria that produce lactic acid compounds. This both creates an environment where harmful microorganisms are unable to grow and contributes to the yoghurt's distinctive taste and texture. Novonesis has developed a range of protective biosolutions that help keep meat, dairy and other food products safe and fresh for longer while maintaining taste and texture

**Case by Novonesis** 

# MATHS IS A KEY INGREDIENT IN REDUCED-SALT SEAFOOD



Danish seafood company Royal Greenland and the Technological University of Denmark came together to find a way to cut the salt without undermining food safety or the taste of seafood products.

With funding from the Green Development and Demonstration Programme (GUDP), they developed a mathematical model for predicting the growth of specific bacteria when parameters such as salt content, pH, temperature and preservatives are altered.

The project equipped Royal Greenland's product developers to predict how a change in the recipe will affect bacterial growth in the final product. As a result, the company has been able to cut the salt content of cold-water prawns in brine and pasteurised lump-fish roe by up to 50%.

All the lightly-preserved fish products in the range have acquired the Nordic Keyhole label – a label that helps consumers identify healthier food products.

The predictive models have been published and are now of benefit to the food industry as a whole.

**Case by Royal Greenland** 

As a result, the company has been able to cut the salt content of cold-water prawns in brine and pasteurised lumpfish roe by up to 50% Salt is widely used in seafood preservation because it inhibits the growth of bacteria and increases product shelf life. But this traditional method can come into conflict with the World Health Organization's dietary guidelines, which recommend that salt intake is less than five grammes a day.

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### CHAPTER 7 **ABOUT FOOD NATION** GATEWAY TO KNOWLEDGE ABOUT THE DANISH FOOD CLUSTER



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### Interested in hearing more about Denmark's strengths as a centre for agri-food innovation supporting food safety and quality? Contact Food Nation.

The Danish food cluster works hand-in-hand with international partners to maintain and improve food safety and quality along the value chain

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Food Nation is a non-profit partnership established by the Danish government and leading private organisations and companies. It is your gateway to information about the Danish food cluster and knowhow that can accelerate the growth of international businesses through better solutions, innovative products and trusting cooperation.

The Danish food cluster encompasses everything from primary production in agriculture and the fishing industry to the food products consumers buy in stores. Companies, universities, research institutes, local and national authorities and other private and public organisations belong to the extensive, collaborative network. Together, they work hand-in-hand with international partners to maintain and improve food safety and quality along the value chain.

#### Take an interactive tour

Food Nation's Visitor Centre in central Copenhagen welcomes international delegations. An interactive installation gives visitors an up-to-date overview of the Danish food and agriculture sector, tailored to individual interests. It is the ideal starting point before visiting Danish food producers and production facilities.

Food Nation is a great place to start learning about how Denmark supports sustainable development through collaboration. Find out more about our services, the Danish food arena and visiting the Food Nation visitor centre at **foodnationdenmark.com** 

